a student of Lathrap's, found similarities between the pottery at Pucallpa in eastern Peru and pottery described by Meggers that had been found along the Napo River in Ecuador. And both of those show similarities to the shards from Marajo Island.

Others found tens of thousands of hectares of raised fields built in the wetlands by prehistoric people in other parts of the Amazon, along the Orinoco River in Venezuela, Guiana's coasts, and the plains of Bolivia, known as the Llanos de Mojos. University of Pennsylvania's Erickson says it was "a real eye-opener" when he first saw raised fields in Llanos de Mojos "in almost every direction, tied by causeways."

"I'm convinced these were complex societies," says Erickson. "In earth-works, they were doing comparable work to the pyramids in terms of earth moved—probably much more in terms of the amount of material moved and landscapes that were completely altered by human occupation."

While most scholars in the field say the new evidence has convinced them that there were complex cultures in the Amazon, the field is still filled with unresolved questions, partly because so few full-scale archeological expeditions have been carried out there. "There's no debate over whether there were complex cultures (anymore)," says William Denevan, a professor of geography at the University of Wisconsin who discovered the first raised fields in 1961 in eastern Bolivia. "The debate is how common these cultures were, where they came from, and how large the populations were."

Some observers, however, are afraid such issues will be difficult to resolve, because researchers may never be able to follow up the preliminary work with a more detailed, closer look. Obstacles to working in the Amazon are considerable. Funding is scarce and problems in the field include such real-world considerations as malaria-bearing mosquitoes and piranhas. The final blow for Weber, who has financed much of his own field-work, is the Shining Path revolutionaries, who have made it unsafe for him to return to the Peruvian Amazon.

Most agree, however, that they've made tremendous progress in the past decade at reconstructing the picture of these lost societies—and showing that the Amazon did indeed have a richer past. "This has certainly changed the static view of the Amazon as an area that was forever primitive and unchanging," says Brown of Northwestern University. "We've begun to pick up a great appreciation for the ways in which large numbers of people were supported in what now are considered marginal environments. I think it's something we're just now beginning to understand."

■ ANN GIBBONS

Quake Prediction by Seismic Oxymora?

As if the term "slow earthquakes" were not sufficiently self-contradictory, seismologists at the recent meeting of the American Geophysical Union meeting in Baltimore were subdividing the category into quiet earthquakes and even silent earthquakes. This proliferation of oxymora is the fallout of an effort to better understand how ordinary, rock-em-sock-em earthquakes get started.

Practically speaking, understanding slow earthquakes could help researchers with the recalcitrant problem of short-term earthquake prediction. The most encouraging news from the AGU session was that slow earthquakes appear to sometimes precede and presumably trigger fast, destructive quakes. That means that some of the instruments being strewn along dangerous faults may provide short-term warnings by noting slow tremblers.

Quiet earthquakes detected in Earth's bell-like ringing may trigger fast, damaging quakes

But slow quakes have long lingered on the fringes of detection. Seismologists have had difficulty showing they exist, much less figuring out how large a role they might have in triggering ordinary, potentially dangerous quakes. The problem is that slow quakes do not register on seismographs the way fast earthquakes do.

Still, seismologists Alan Linde and Selwyn Sacks of the Carnegie Institution of Washington's Department of Terrestrial Magnetism wouldn't say no to a challenge. They told session attendees of their long search for the slowest of the slow earthquakes, the silent earthquakes.

Seismologists' nomenclature has not settled down yet, but two extremes have been clearly defined. Fast and therefore noisy quakes are ruptures that rip along faults at more than 3600 kilometers per hour while rattling off seismic waves, the strongest of which are easily recorded on seismographs around the world. At the other end of the spectrum, silent earthquakes are far pokier, rupturing at less than 36 kilometers per hour—so slow that they go undetected by standard seismographs.

Conventional instruments being of little use, Linde and Sacks installed strainmeters, which can sense these silent ruptures by the crust deformation they cause, near faults in quake-prone Japan and Iceland. With patience and luck, Sacks and Linde detected silent earthquakes at three places in a dozen years. In the Japan Sea in 1983, for instance, they recorded about 100 silent events lasting 3 hours, each where a magnitude 7.7 quake subsequently struck. Sacks and Linde believe that the events were silent ruptures propagating upward along 60 kilometers of fault toward the site of the eventual fast rupture. Each silent rupture would have increased the strain on that section of the fault until it broke in a fast earthquake.

Seismologists Gregory Beroza and Thomas Jordan of the Massachusetts Institute of Technology reported that they have found another means of detecting some kinds of slow earthquakes, one that does not require an instrument near every fault. They looked at data from accelerometers located around the world. These instruments detect the ground motion touched off when a large earthquake sets the planet ringing like a bell, a phenomenon known as free oscillations.

Over 10 years, Earth rang with free oscillations 1500 times. In most cases, seismographs recorded ordinary earthquakes that set off the free oscillations. But in a number of cases, the accompanying quakes appeared to be too small for the job. Beroza and Jordan argue that these are earthquakes fast enough to generate some seismic waves—they are not silent—but slower than ordinary quakes. Most were located on the faults connecting sections of mid-ocean ridges, supporting the idea that the hot rock there can rupture slowly.

Another 164 of the 1500 free-oscillation events had no recorded earthquake associated with them. These Beroza and Jordan call quiet earthquakes, which are not as slow as silent quakes but produce only the slightest whisper of certain low-frequency seismic waves. Using his own mathematical technique, Jordan believes he can show that at least a few of these quiet quakes, which last some minutes and release as much energy as a magnitude 6 or larger quake, immediately preceded and probably triggered fast earthquakes of comparable size.

Beroza and Jordan must now convince their colleagues that their methods are as reliable as they claim. If they do, the continuing proliferation of slow precursory earthquakes would provide further reassurance to those in the prediction business—there really may be something to measure immediately before some faults fail in destructive earthquakes.

■ RICHARD A. KERR